USB2815

User’s Manual

Beijing ART Technology Development Co., Ltd.

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Chapter 1 Overview

In the fields of Real-time Signal Processing, Digital Image Processing and others, high-speed and high-precision data acquisition modules are demanded. ART USB2815 data acquisition module, which brings in advantages of similar products that produced in china and other countries, is convenient for use, high cost and stable performance.

ART USB2815 is a data acquisition module based on USB bus. It can be directly inserted into USB interface to constitute the laboratory, product quality testing center and systems for different areas of data acquisition, waveform analysis and processing. It may also constitute the monitoring system for industrial production process.

Unpacking Checklist

Check the shipping carton for any damage. If the shipping carton and contents are damaged, notify the local dealer or sales for a replacement. Retain the shipping carton and packing material for inspection by the dealer.
Check for the following items in the package. If there are any missing items, contact your local dealer or sales.

- USB2815 Data Acquisition Board
- ART Disk
  a) user's manual (pdf)
  b) drive
  c) catalog
- Warranty Card

FEATURES

AD analog input

- Input Range: ±10V, ±5V, ±2.5, 0~10V, 0~5V
- 16-bit resolution
- Sampling Rate: maximum 250KHz
- Analog Input Mode: 16SE/8DI
- Data Read Mode: non-empty, half-full inquiry mode
- Memory Depth: 8K word FIFO memory
- Memory Signs: non-empty, half-full and overflow
- AD Mode: continuum sampling , grouping sampling
- Group Interval: software-configurable, minimum value is sampling period, maximum value is 419430uS
- Loops of Group: software-configurable, minimum value is one time , maximum value is 255 times
- Clock Source: external clock, internal clock(software-configurable)
- Trigger Mode: software trigger, hardware trigger(external trigger)
- Trigger Type: level trigger , edge trigger
- Trigger Direction: negative, positive, either positive or negative trigger
- Trigger Source: ATR, DTR
- Analog Trigger Source (ATR)Input Range: ±10V
- Digital Trigger Source (DTR) Input Range: standard TTL level
- AD Conversion Time: 1.25uS
- Programmable Gain: 1, 2, 4, 8 (AD8251 default)or 1, 2, 5, 10 (AD8250) or 1, 10, 100, 1000 (AD8253)

- Analog Input Impedance: 10MΩ
- Amplifier Set-up Time: 785nS(0.001%)(max)
- Non-linear error: ±3LSB(Maximum)
- System Measurement Accuracy: 0.01%
- Operating Temperature Range: 0℃~55℃
- Storage Temperature Range: −20℃~70℃

DA analog output

- Output Range: ±10V,±5V, 0~10V, 0~5V
- 12-bit resolution
- Set-up Time: 10μS (0.01%)
- Channel No.: 4-channel
- Non-linear error: ±1LSB(Maximum)
- Output Error (full-scale): ±1LSB
- Operating Temperature Range: 0℃~55℃
- Storage Temperature Range: −20℃~+70℃

DI digital input

- Channel No.: 8-channel
- Electric Standard: CMOS compatible
- High Voltage: ≧3.5V
- Low Voltage: ≦1.5V

DO digital output

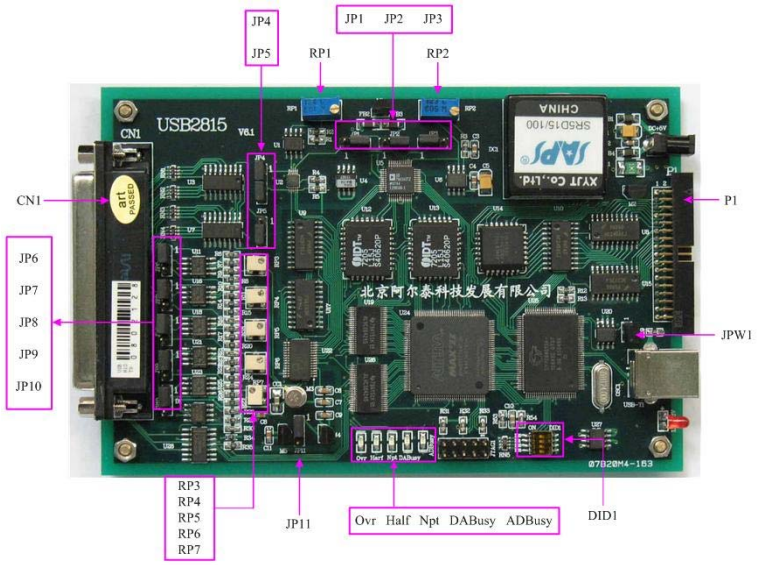
- Channel No.: 8-channel
- Electrical Standard: CMOS compatible
- High Voltage: ≧4.45V
- Low Voltage: ≦0.5V

Counter/timer

- Counter No.: 3 separate counter
- Counter mode: subtractive counter
- Number of digits of the counter: 16-bit
- Operate Type: 4 operate type (software-configurable)
- Counting Mode: 6 counting mode(software-configurable)
- Counting Type: binary counting and BCD code counting
- Input Electric Standard: High Level≧2.2V, Low Level≦0.8V
- Output Electric Standard: High Level≧3.0V, Low Level≦0.4V

Chapter 2 Components Layout Diagram and a Brief Description

2.1 The Main Component Layout Diagram



2.2 The Function Description for the Main Component

2.2.1 Signal Input and Output Connectors

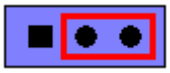
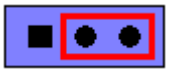
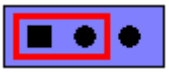
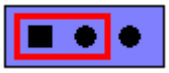
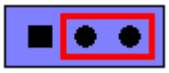
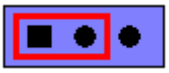
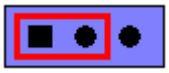
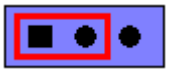
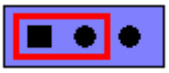
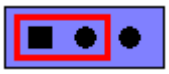
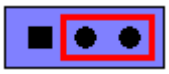
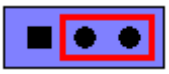
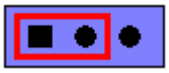
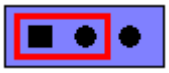
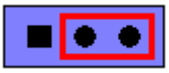
CN1: analog signal input and output connector
P1: digital signal input and output connector

2.2.2 Potentiometer

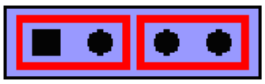
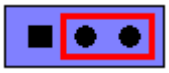
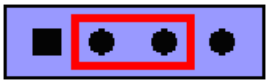
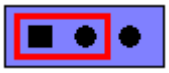
RP1: Analog signal input zero-point adjustment potentiometer
RP2: Analog signal input full-scale adjustment potentiometer
RP3: DA0 analog signal output full-scale adjustment potentiometer
RP4: DA1 analog signal output full-scale adjustment potentiometer
RP5: DA2 analog signal output full-scale adjustment potentiometer
RP6: DA3 analog signal output full-scale adjustment potentiometer
RP7: DA analog signal output zero-point adjustment potentiometer

2.2.3 Jumper

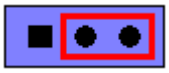
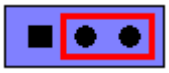
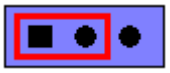
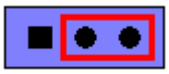
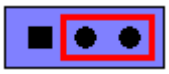
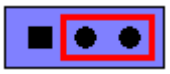
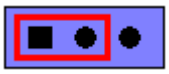
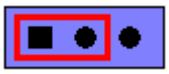
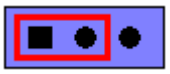
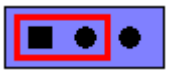
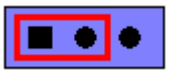
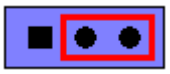
JP1, JP2, and JP3: Analog signal input range setting

Voltage Range	JP1	JP2	JP3
±10V			
±5V			
±2.5V			
0~10V			
0~5V			

JP4, JP5: Analog signal input mode setting

Input mode	JP4	JP5
Single-ended		
Different-ended		

JP10, JP11, JP6, JP7, JP8, and JP9: Analog signal output range setting

Voltage Range	JP10	JP11	JP6(AO0) JP7(AO1) JP8(AO2) JP9(AO3)
0~5V			
0~10V			
±5V			
±10V			

2.2.4 Status indicator

Ovr: FIFO overflow status indicator. On for overflowing.

Half: FIFO half-full status indicator.

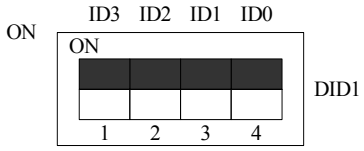
Npt: FIFO non-empty status indicator

DABusy: DA working status indicator. When the light is on, it shows that DA is working.

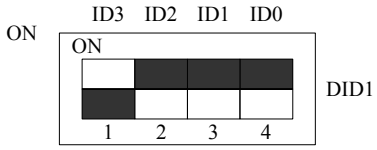
ADBusy: AD working status indicator. When the light is on, it shows that AD is working.

2.2.5 Physical ID of DIP Switch

DID1: Set physical ID number. When the PC is installed more than one USB2815 , you can use the DIP switch to set a physical ID number for each board, which makes it very convenient for users to distinguish and visit each board in the progress of the hardware configuration and software programming. The following four-byte numbers are expressed by the binary system: When DIP switch points to "ON", that means "1", and when it points to the other side, that means "0." As they are shown in the following diagrams: byte "ID3" is the high byte."ID0" is the low byte, and the black part in the diagram represents the location of the switch. (Test softwares of the company often use the logic ID management equipments and at this moment the physical ID DIP switch is invalid. If you want to use more than one kind of the equipments in one and the same system at the same time, please use the physical ID as much as possible.).



The above chart shows"1111", so it means that the physical ID is 15.



The above chart shows"0111", so it means that the physical ID is 7.

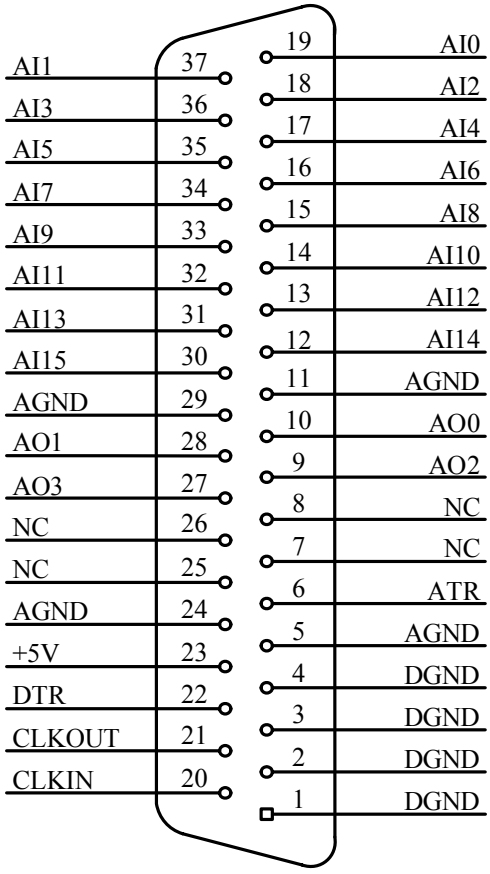
The above chart shows"0101", so it means that the physical ID is 5.

ID3	ID2	ID1	ID0	Physical ID（Hex）	Physical ID（Dec）
OFF（0）	OFF（0）	OFF（0）	OFF（0）	0	0
OFF（0）	OFF（0）	OFF（0）	ON（1）	1	1
OFF（0）	OFF（0）	ON（1）	OFF（0）	2	2
OFF（0）	OFF（0）	ON（1）	ON（1）	3	3
OFF（0）	ON（1）	OFF（0）	OFF（0）	4	4
OFF（0）	ON（1）	OFF（0）	ON（1）	5	5
OFF（0）	ON（1）	ON（1）	OFF（0）	6	6
OFF（0）	ON（1）	ON（1）	ON（1）	7	7
ON（1）	OFF（0）	OFF（0）	OFF（0）	8	8
ON（1）	OFF（0）	OFF（0）	ON（1）	9	9
ON（1）	OFF（0）	ON（1）	OFF（0）	A	10
ON（1）	OFF（0）	ON（1）	ON（1）	B	11
ON（1）	ON（1）	OFF（0）	OFF（0）	C	12
ON（1）	ON（1）	OFF（0）	ON（1）	D	13
ON（1）	ON（1）	ON（1）	OFF（0）	E	14
ON（1）	ON（1）	ON（1）	ON（1）	F	15

Chapter 3 Signal Connectors

3.1 The Definition of Signal Input and Output Connectors

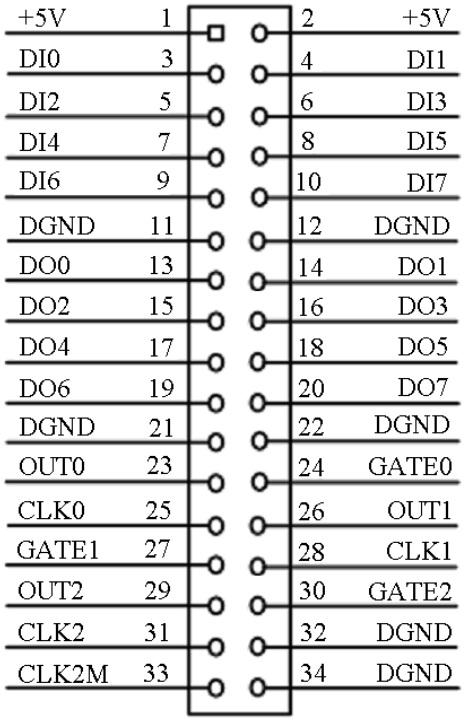
CN1: 37-pin D-type definition



Pin definition about AD:

Pin name	Type	Pin function definition
AI0~AI15	Input	Analog input, reference ground is AGND.
AO0~AO3	Output	Analog output, reference ground is AGND.
AGND	GND	Analog ground. This AGND pin should be connected to the system's AGND plane.
DGND	GND	Digital ground. Ground reference for Digital circuitry. This DGND pin should be connected to the system's DGND plane.
CLKIN	Input	External clock input, please use DGND as reference ground.
CLKOUT	Output	Internal clock output
ATR	Input	Analog trigger signal input, choose AGND as reference ground.
DTR	Input	Digital trigger signal input, choose DGND as reference ground.
+5V	Output	5V power supply output.
NC		Not connected

Pin definition about Digital Input/Output



Pin name	Pin feature	Pin function definition
DI0~DI7	Input	Digital signal input, reference ground is DGND.
DO0~DO7	Output	Digital signal output, reference ground is DGND.
+5V	Output	5V power supply output..
CLK2M	Output	On-board 2MHz clock oscillator pulse output, Output cycle 0.5 microseconds, provides the clock source signal for CLK0~CLK2
CLK0~CLK2	Input	Clock / pulse input pins for 3 channels of 8254 counters.
GATE0~GATE2	Input	Gate input pins for 3 channels of 8254 counters
OUT0~OUT2	Output	Output pins of 3 channels of 8254 counters
DGND	GND	Digital signals ground, when use counter/timer we best choose it as reference ground.

Chapter 4 Connection Ways for Each Signal

4.1 Analog Input Single-ended Connection

Single-ended mode can achieve a signal input by one channel, and several signals use the common reference ground. This mode is widely applied in occasions of the small interference and relatively many channels.

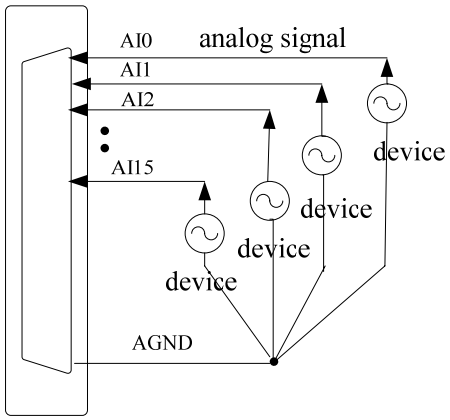


Figure 4.1 single-ended input connection

4.2 Analog Input Differential-ended Mode

Double-ended input mode, which was also called differential input mode, uses positive and negative channels to input a signal. This mode is mostly used when biggish interference happens and the channel numbers are few. Single-ended/double-ended mode can be set by the software, please refer to USB2815 software manual.

According to the diagram below, USB2815 board can be connected as analog voltage double-ended input mode, which can effectively suppress common-mode interference signal to improve the accuracy of acquisition. Positive side of the 8-channel analog input signal is connected to AI0~AI7, the negative side of the analog input signal is connected to AI8~AI15, equipments in industrial sites share the AGND with USB2815 board.

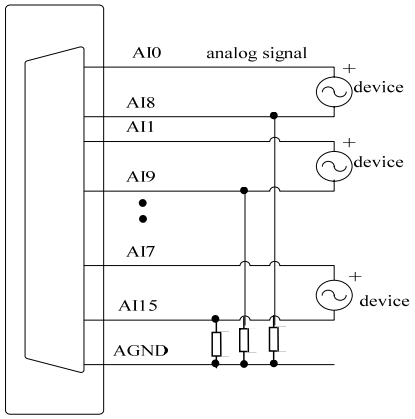


Figure 4.2 double-ended input connection

4.2 Other Connections

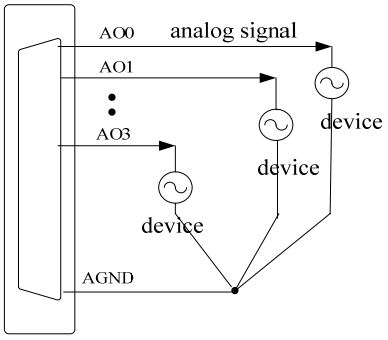


Figure 4.3 analog signal output connection

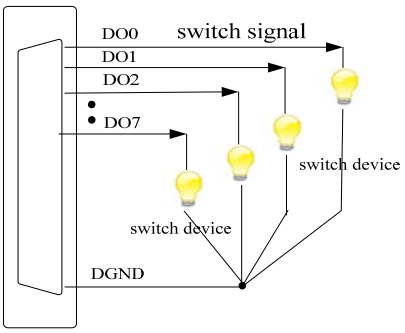


Figure 4.5 digital signal output connection

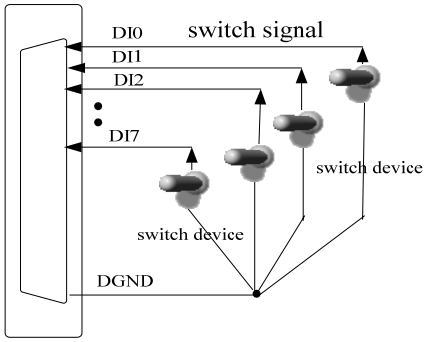


Figure 4.4 digital signal input connection

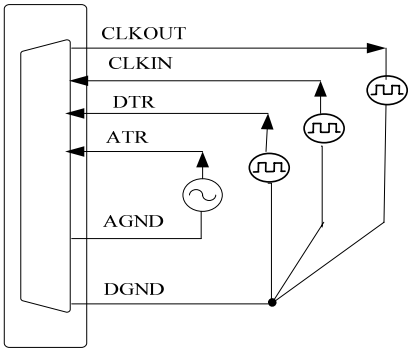
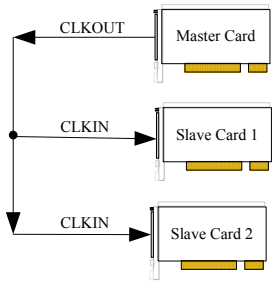


Figure 4.6 Clock Input/Output and Trigger Signal Connection

4.3 Methods of Realizing the Multi-card Synchronization

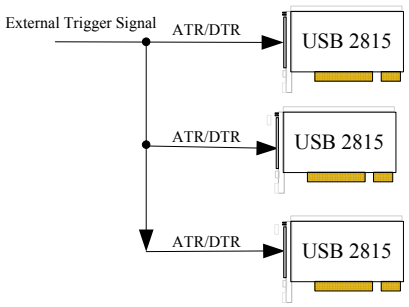
Three methods can realize the synchronization for the USB2815, the first method is using the cascade master-slave card, the second one is using the common external trigger, and the last one is using the common external clock.

When using master-slave cascade card programs, the master card generally uses the internal clock source model, while the slave card uses the external clock source mode. After the master card and the slave card are initialized according to the corresponding clock source mode. At first, start all the slave cards, as the main card has not been activated and there is no output clock signal, so the slave card enters the wait state until the main card was activated. At this moment, the multi-card synchronization has been realized. When you need to sample more than channels of a card, you could consider using the multi-card cascaded model to expand the number of channels.



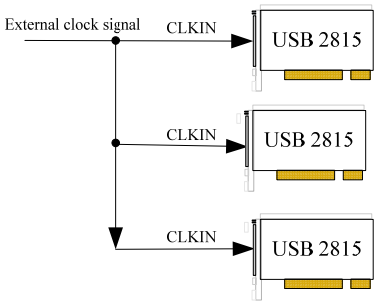
When using the common external trigger, please make sure all parameters of different USB2815 are the same. At first, configure hardware parameters, and use analog or digital signal triggering (ATR or DTR), then connect the signal that will be sampled by USB2815, input triggering signal from ART pin or DTR pin, then click “Start Sampling” button, at this time, USB2815 does not

sample any signal but waits for external trigger signal. When each module is waiting for external trigger signal, use the common external trigger signal to startup modules, at last, we can realize synchronization data acquisition in this way. See the following figure:



Note:when using the DTR, select the internal clock mode

When using the common external clock trigger, please make sure all parameters of different USB2815 are the same. At first, configure hardware parameters, and use external clock, then connect the signal that will be sampled by USB2815, input trigger signal from ART pin or DTR pin, then click “Start Sampling” button, at this time, USB2815 does not sample any signal, but wait for external clock signal. When each module is waiting for external clock signal, use the common external clock signal to startup modules, at last, we realize synchronization data acquisition in this way. See the following figure:



Chapter 5 The Instruction of the AD Trigger Function

5.1 AD Internal Trigger Mode

When AD is in the initialization, if the AD hardware parameter ADPara.TriggerMode = USB2815_TRIGMODE_SOFT, we can achieve the internal trigger acquisition. In this function, when calling the StartDeviceProAD function, it will generate AD start pulse, AD immediately access to the conversion process and not wait for the conditions of any other external hardware. It also can be interpreted as the software trigger.

As for the specific process, please see the figure below, the cycle of the AD work pulse is decided by the sampling frequency.

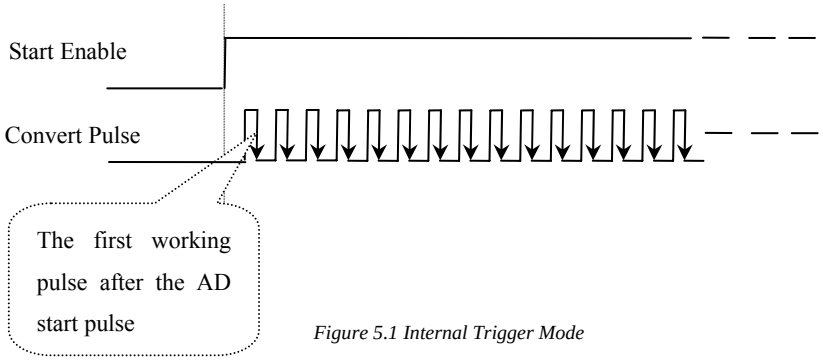


Figure 5.1 Internal Trigger Mode

5.2 AD External Trigger Mode

When AD is in the initialization, if the AD hardware parameter ADPara.TriggerMode = USB2815_TRIGMODE_POST, we can achieve the external trigger acquisition. In this function, when calling the StartDeviceProAD function, AD will not immediately access to the conversion process but wait for the external trigger source signals accord with the condition, then start converting the data. It also can be interpreted as the hardware trigger. Trigger source includes the DTR (Digital Trigger Source) and ATR (Analog Trigger Source)

The trigger modes include the edge trigger and level trigger.

5.2.1 Edge Trigger Function

Edge trigger is to capture the characteristics of the changes between the trigger source signal and the trigger level signal to trigger AD conversion.

When ADPara.TriggerDir = USB2815_TRIGDIR_NEGATIVE, choose the trigger mode as the falling edge trigger. That is, when the DTR trigger signal is on the falling edge, AD will immediately access to the conversion process, and its follow-up changes have no effect on AD acquisition.

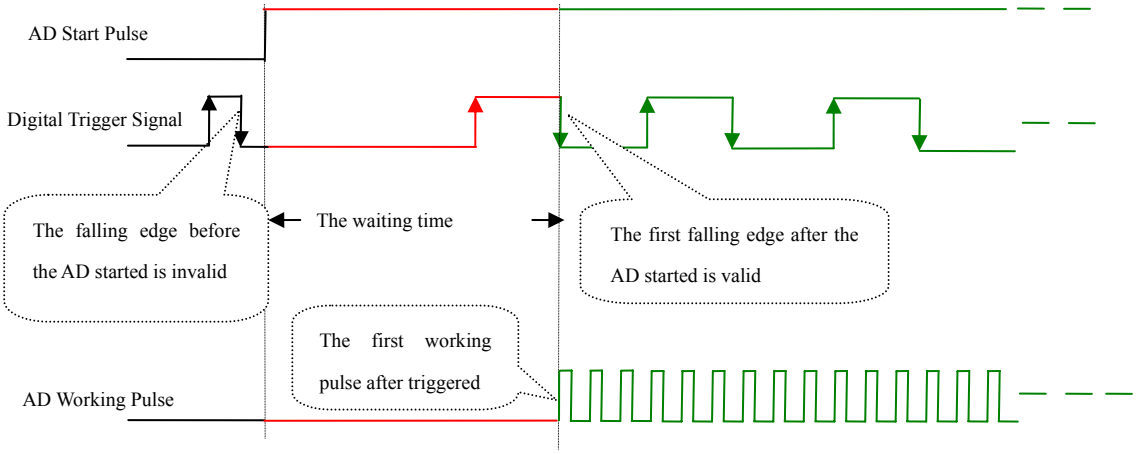


Figure5.2 Digital Trigger Source，Falling edge Trigger

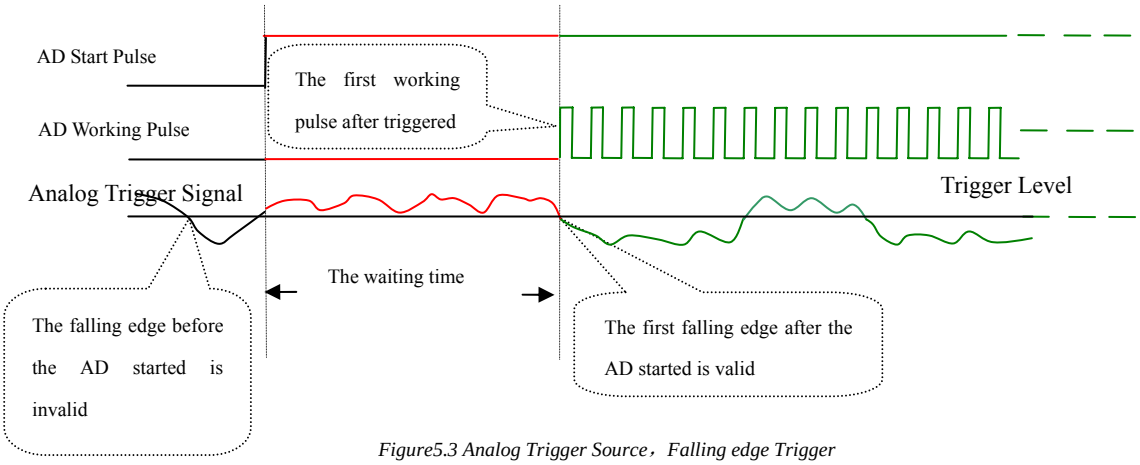


Figure5.3 Analog Trigger Source，Falling edge Trigger

When ADPara.TriggerDir = USB2815_TRIGDIR_POSITIVE, choose the trigger mode as rising edge trigger. That is, when the DTR trigger signal is on the rising edge, AD will immediately access to the conversion process, and its follow-up changes have no effect on AD acquisition.

When ADPara.TriggerDir = USB2815_TRIGDIR_POSIT_NEGAT, choose the trigger mode as rising or falling edge trigger. That is, when the DTR trigger signal is on the rising or falling edge, AD will immediately access to the conversion process, and its follow-up changes have no effect on AD acquisition. This function can be used in the case that the acquisition will occur if the **exoteric** signal changes.

5.2.2 Triggering Level Function

Level trigger is to capture the condition that trigger signal is higher or lower than the trigger level to trigger AD conversion.

When ADPara.TriggerDir = USB2815_TRIGDIR_ NEGATIVE, it means the trigger level is low. When DTR trigger signal is in low level, AD is in the conversion process, once the trigger signal is in the high level, AD conversion will automatically stop, when the trigger signal is in the low level again, AD will re-access to the conversion process, that is, only converting the data when the trigger signal is in the low level.

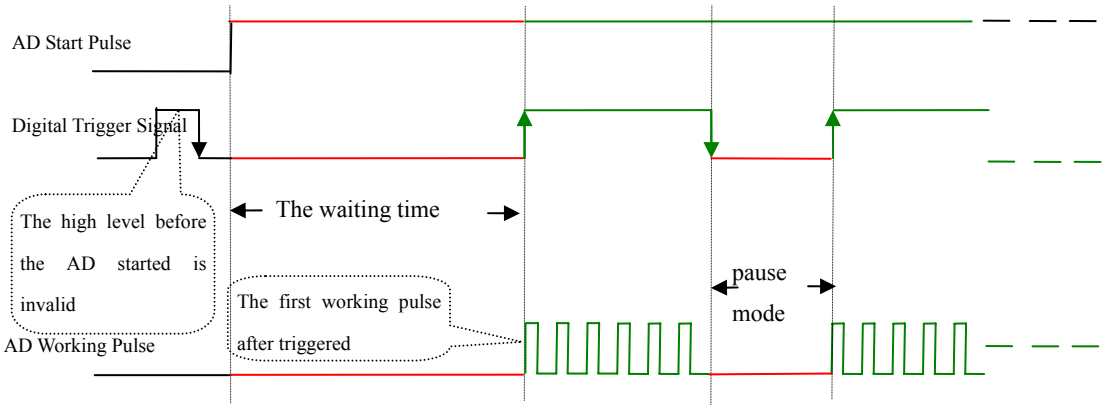


Figure5.4 Digital Trigger Source，High Level Trigger

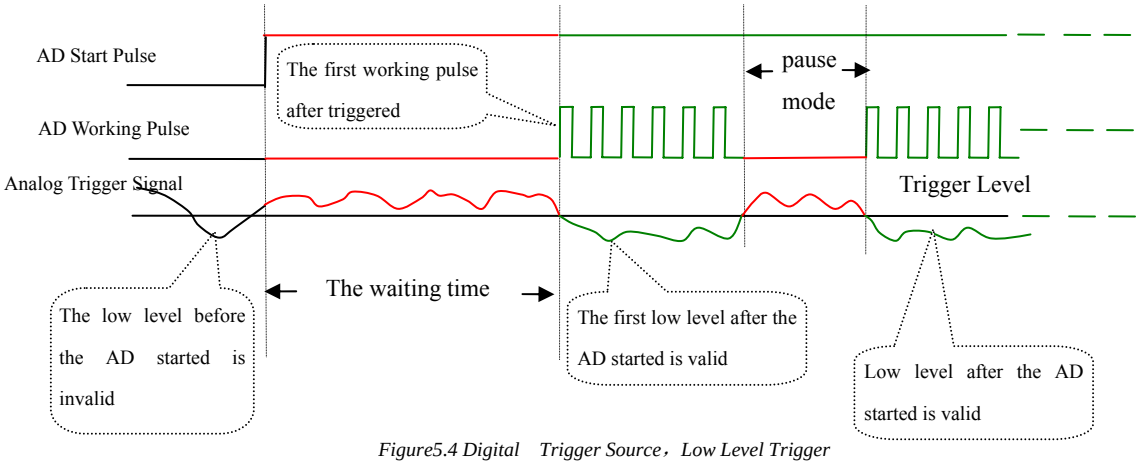


Figure5.4 Digital Trigger Source，Low Level Trigger

When ADPara.TriggerDir = USB2815_TRIGDIR_POSITIVE, it means the trigger level is high. When DTR trigger signal is in high level, AD is in the conversion process, once the trigger signal is in the low level, AD conversion will automatically stop, when the trigger signal is in the high level again, AD will re-access to the conversion process, that is, only converting the data when the trigger signal is in the high level.

When ADPara.TriggerDir = USB2815_TRIGDIR_POSIT_NEGAT, the effect is the same as choosing the internal software trigger.

Chapter 6 Methods of using AD Internal and External Clock Function

6.1 Internal Clock Function of AD

Internal Clock Function refers to the use of on-board clock oscillator and the clock signals which are produced by the user-specified frequency to trigger the AD conversion regularly. To use the clock function, the hardware parameters ADPara.ClockSource = USB2815 _CLOCKSRC_IN should be installed in the software. The frequency of the clock in the software depends on the hardware parameters ADPara.Frequency. For example, if Frequency = 100000, that means AD work frequency is 100000Hz (that is, 100 KHz, 10μs /point).

6.2 External Clock Function of AD

External Clock Function refers to the use of the outside clock signals to trigger the AD conversion regularly. The clock signals are provide by the CLKIN pin of the CN1 connector. The outside clock can be provided by USB2815 clock output (CLKOUT of CN1), as well as other equipments, for example clock frequency generators. To use the external clock function, the hardware parameters ADPara.ClockSource = USB2815_CLOCKSRC_OUT should be installed in the software. The clock frequency depends on the frequency of the external clock, and the clock frequency on-board (that is, the frequency depends on the hardware parameters ADPara.Frequency) only functions in the packet acquisition mode and its sampling frequency of the AD is fully controlled by the external clock frequency.

6.3 Methods of Using AD Continuum and Grouping Sampling Function

6.3.1 AD Continuum Sampling Function

The continuous acquisition function means the sampling periods for every two data points are completely equal in the sampling process of AD, that is, completely uniform speed acquisition, without any pause, so we call that continuous acquisition.

To use the continuous acquisition function, the hardware parameters ADPara.ADMode = USB2815 _ADMODE_SEQUENCE should be installed in the software. For example, in the internal clock mode, hardware parameters ADPara.Frequency = 100000 (100KHz) should be installed, and 10 microseconds after the AD converts the first data point, the second data point conversion starts, and then 10 microseconds later the third data point begins to convert, and so on.

6.3.2 AD Grouping Sampling Function

Grouping acquisition (pseudo-synchronous acquisition) function refers to the sampling clock frequency conversion among the channels of the group in the AD sampling process, and also a certain waiting time exists between every two groups, this period of time is known as the Group Interval. Loops of group refer to numbers of the cycle acquisition for each channel in the same group. In the internal clock mode and the fixed-frequency external clock mode, the time between the groups is known as group cycle. The conversion process of this acquisition mode as follows: a short time stop after the channels conversion in the group (that is, Group Interval), and then converting the next group, followed by repeated operations in order, so we call it grouping acquisition.

The purpose of the application of the grouping acquisition is that: at a relatively slow frequency, to ensure that all of the time difference between channels to become smaller in order to make the phase difference become smaller, thus to ensure the synchronization of the channels, so we also say it is the pseudo-synchronous acquisition function. In a group, the higher the sampling frequency is, the longer Group Interval is, and the better the relative synchronization signal is. The sampling frequency in a group depends on ADPara. Frequency, Loops of group depends on ADPara.LoopsOfGroup, the Group Interval depend on ADPara. Group Interval.

Based on the grouping function, it can be divided into the internal clock mode and the external clock mode. Under the internal clock mode, the group cycle is decided by the internal clock sampling period, the total number of sampling channels, Loops of group and Group Interval together. In each cycle of a group, AD only collects a set of data. Under the external clock mode, external clock cycle ≥ internal clock sampling cycle × the total number of sampling channels × Loops of group + AD chip conversion time, AD data acquisition is controlled and triggered by external clock. The external clock mode is divided into fixed frequency external clock mode and unfixed frequency external clock mode. Under the fixed frequency external clock mode, the group cycle is the sampling period of the external clock.

The formula for calculating the external signal frequency is as follows:

Under the internal clock mode:
Group Cycle = the internal clock sampling period × the total number of sample channels × Loops of group + AD chips conversion time + Group Interval
External signal cycle = (cycle signal points / Loops of group) × Group Cycle
External signal frequency = 1 / external signal cycle

Under the external clock mode: (a fixed-frequency external clock)
Group Cycle = external clock cycle
External signal cycle = (cycle signal points / Loops of group) × Group Cycle
External signal frequency = 1 / external signal cycle

Formula Notes:
The internal sampling clock cycle = 1 / (AD Para. Frequency)
The total number of sampling channels = AD Para. Last Channel – AD Para. First Channel + 1

Loops of group == ADPara.LoopsOfGroup
AD Chips conversion time = see "AD Analog Input Function" parameter
Group Interval = AD Para. Group Interval
Signal Cycle Points = with the display of the waveform signal in test procedures, we can use the mouse to measure the signal cycle points.

Under the internal clock mode, for example, sample two-channel 0, 1, and then 0 and 1 become a group. Sampling frequency (Frequency) = 100000Hz (cycle is 10μs), Loops of group is 1, Group Interval = 50μs, then the acquisition process is to collect a set of data first, including a data of channel 0 and a data of channel 1. We need 10uS to sample the two data, 20μs to convert the data from the two channels. After the conversion time of an AD chip, AD will automatically cut-off to enter into the waiting state until the 50μs group interval ends. We start the next group, begin to convert the data of channel 0 and 1, and then enter into the waiting state again, and the conversion is going on in this way, as the diagram following shows:

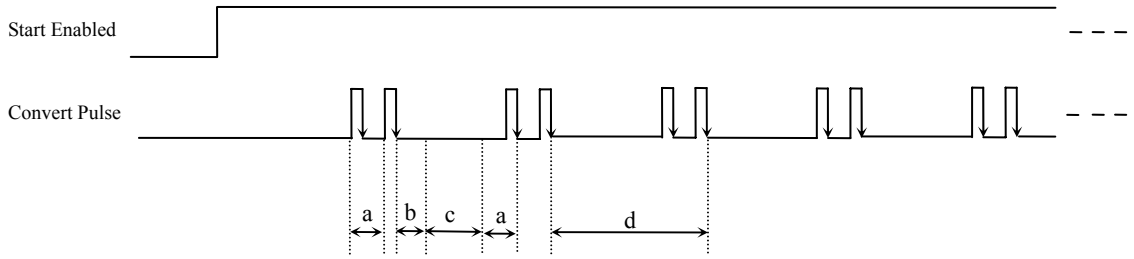


Figure 6.1 Grouping Sampling which grouping cycle No is 1 under the Internal Clock Mode

Note: a— internal clock sample cycle
b— AD chips conversion time
c—Group Interval
d— group cycle

Change the loops of group into 2, then the acquisition process is to collect the first set of data, including two data of channel 0 and two data of channel 1, the conversion order is 0,1,0,1. We need 10μs to sample each of the four data. After the conversion time of an AD chip, AD will automatically stop to enter into the waiting state until the 50μs Group Interval ends. We start the next group, begin to convert the data of channel 0 and 1, and then enter into the waiting state again, and the conversion is going on in this way, as the diagram following shows:

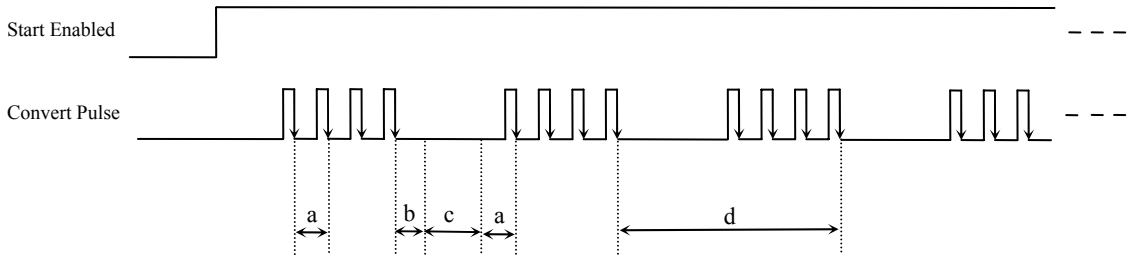


Figure 6.2 Grouping Sampling which grouping cycle No is 2 under the Internal Clock Mode

Notes: a— internal clock sample cycle

b— AD chips conversion time
c—Group Interval
d— group cycle

Under the external clock mode, the requirement is: the external clock cycle ≥ the internal clock sampling period × the total number of sampling channels× Loops of group + AD chip conversion time, otherwise, the external clock appearing in the group conversion time will be ignored.

Under the fixed-frequency external clock mode, for example, when sampling data of two-channel 0, 1, then channel 0 and channel 1 consist of a group. Sampling frequency (Frequency) = 100000Hz (the cycle is 10μs), Loops of group is 2, then the acquisition process is to collect the first set of data, including two data of channel 0 and two data of channel 1, the order of conversion 0,1,0,1, We need 10μs to sample the four data and 40μs to convert of the four data. After the conversion time of an AD chip, AD will automatically stop to enter into the waiting state until the next edge of the external clock triggers AD to do the next acquisition, and the conversion is going on in this way, as the diagram following shows:

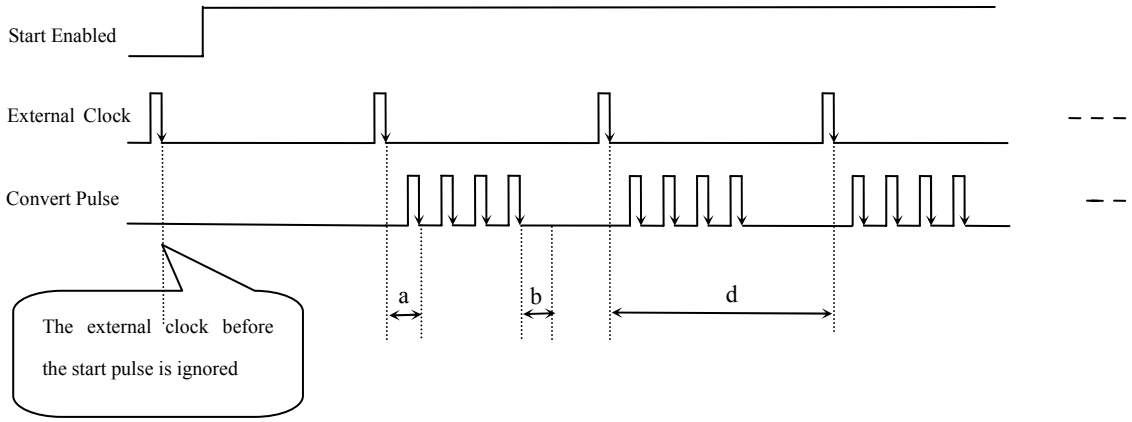


Figure 6.3 Grouping sampling under the fixed frequency external clock mode

Notes: a— internal clock sample cycle
b—AD chips conversion time
d—group cycle（external clock cycle）

Under an unfixed-frequency external clock mode, for example, the grouping sampling principle is the same as that of the fixed-frequency external clock mode. Under this mode, users can control any channel and any number of data. Users will connect the control signals with the clock input of the card (CLKIN), set the sampling channels and Loops of group. When there are external clock signals, it will sample the data which is set by users. Because the external clock frequency is not fixed, the size of external clock cycle is inconsistent but to meet: the external clock cycle ≥ the internal clock sampling period × the total number of sampling channels × Loops of group + AD chip conversion time, , otherwise, the external clock edge appearing in the group conversion time will be ignored.

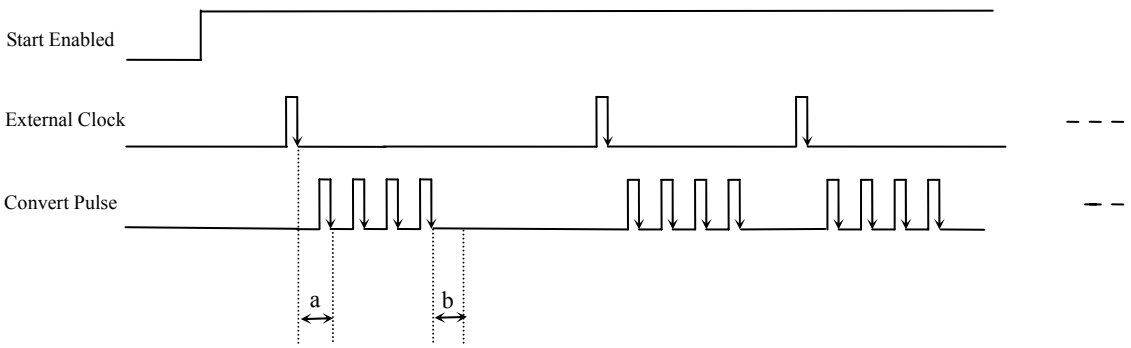


Figure 6.4 Grouping sampling under the not fixed frequency external clock mode

Note: a— internal clock sample cycle
b—AD chips conversion time

Chapter 7 Methods of using Timer/Counter 8254

7.1 The working mode

MODE 0 Interrupt on terminal count

Mode 0 is typically used for event counting. After the Control Word is written, OUT is initially low, and will remain low until the Counter reaches zero. OUT then goes high and remains high until a new count or a new Mode 0 Control Word is written into the Counter.

GATE=1 enables counting; GATE=0 disables counting. GATE has no effect on OUT.

After the Control Word and initial count are written to a Counter, the initial count will be loaded on the next CLK pulse. This CLK pulse does not decrement the count, so for an initial count of N, OUT does not go high until N+1 CLK pulses after the initial count is written.

If a new count is written to the Counter, it will be loaded on the next CLK pulse and counting will continue from the new count. If a two-byte count is written, the following happens:
1) Writing the first byte disables counting. OUT is set low immediately (no clock pulse required)
2) Writing the second byte allows the new count to be loaded on the next CLK pulse

This allows the counting sequence to be synchronized by software. Again, OUT does not go high until N+1 CLK pulses after the new count of N is written.

If an initial count is written while GATE=0, it will still be loaded on the next CLK pulse. When GATE goes high, OUT will go high N CLK pulse later, no CLK pulse is needed to load the Counter as this has already been done.

MODE 1 Hardware retriggerable one-shot

OUT will be initially high. OUT will go low on the CLK pulse following a trigger to begin the one-shot pulse, and will remain low until the Counter reaches zero.
OUT will then go high and remain high until the CLK pulse after the next trigger.

After writing the Control Word and initial count, the Counter is armed. A trigger results in loading the Counter and setting OUT low on the next CLK pulse, thus starting the one-shot pulse. An initial count of N will result in a one-shot pulse N CLK cycles in duration. The one-shout is retriggerable, hence OUT will remain low for N CLK pulses after any trigger. The one-shot pulse can be repeated without rewriting the same count into the counter. GATE has no effect on OUT.
If a new count is written to the Counter during a one-shot pulse, the current one-shot is not affected unless the counter is retriggered. In that case, the Counter is loaded with the new count and the one-shot pulse continues until the new count expires.

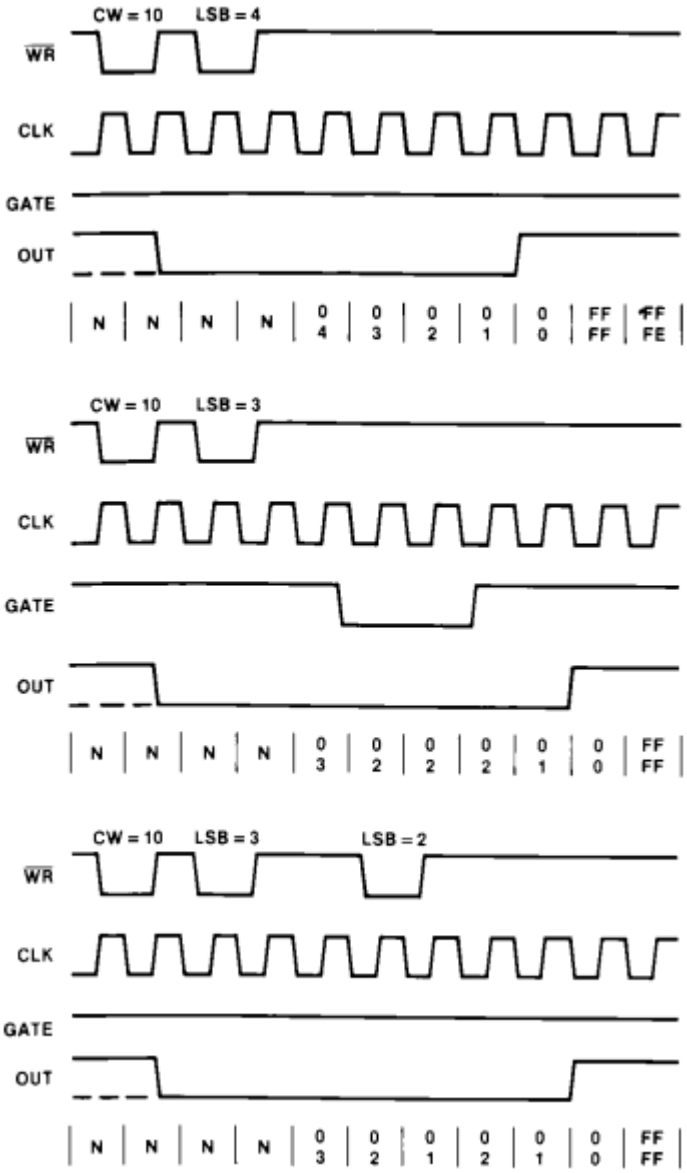


Figure 7.1 Mode 0

NOTE

The following conventions apply to all mode timing diagrams

1. Counters are programmed for binary (not BCD) counting and for reading/writing least significant byte (LSB) only.

2. The counter is always selected ($\overline{CS}$ always low) ***错误！未指定书签。***

3. CW stands for "Control Word"; CW=10 means a control word of 10 HEX is written to the counter.

4. LSB stands for "Least Significant Byte" of count.

5. Numbers below diagrams are count values. The lower number is the least significant byte. The upper number is the most significant byte.

Since the counter is programmed to read/writer LSB only, the most significant byte cannot be read.

N stands for an undefined count.

Vertical lines show transitions between count values.

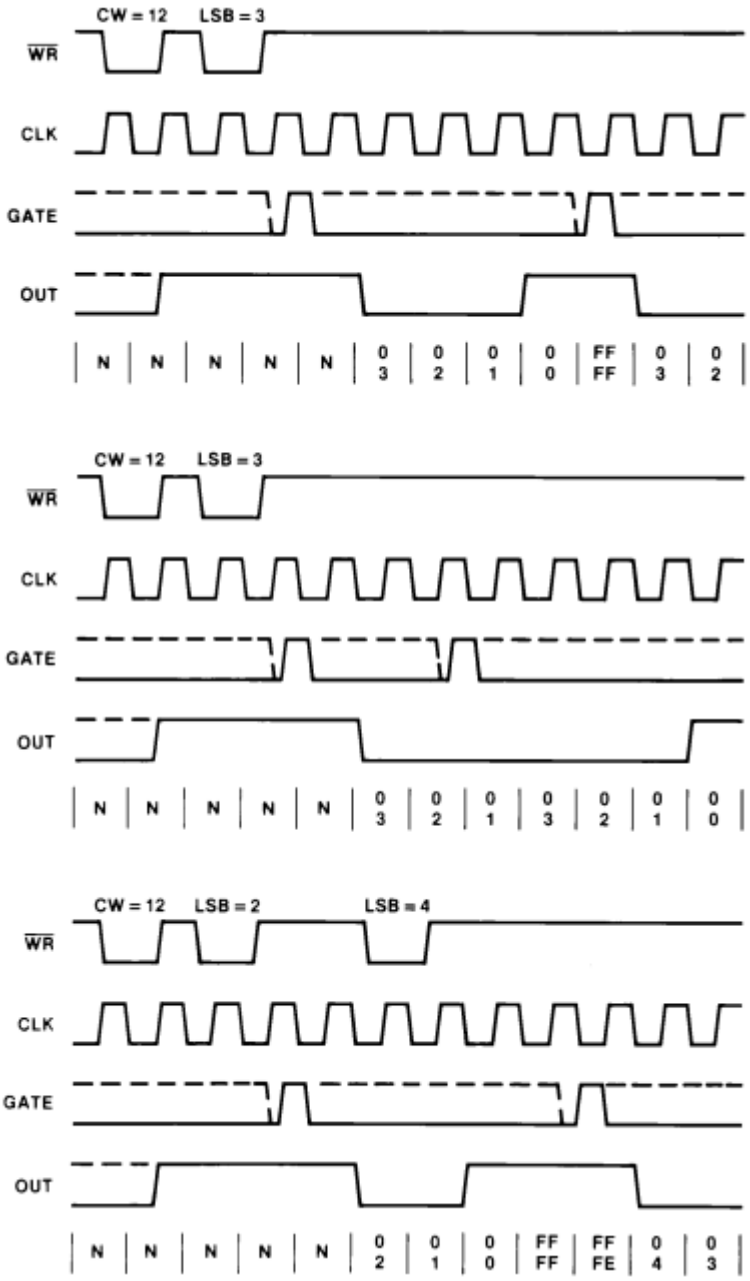


Figure 7.2 Mode 1

MODE 2 Rate Generator

This Mode functions like a divide-by-N counter. It is typically used to generate a Real Time Clock interrupt. OUT will initially be high. When the initial count has decremented to 1, OUT goes low for on CLK pulse. OUT then goes high again, the Counter reloads the initial count and the process is repeated. Mode 2 is periodic; the same sequence is repeated indefinitely. For an initial count of N, the sequence repeats every N CLK cycles.

GATE=1 enables counting; GATE=0 disables counting. If GATE goes low during an output pulse, OUT is set high immediately. A trigger reloads the Counter with the initial count on the next CLK pulse; OUT goes low N CLK pulses after the trigger. Thus the GATE input can be used to synchronize the Counter.

After writing a Control Word and initial count, the Counter will be loaded on the next CLK pulse. OUT goes low N CLK Pulses after the initial count is written. This allows the Counter to be synchronized by software also.

Writing a new count while counting does not affect the current counting sequence. If a trigger is received after writing a new count but before the end of the current period, the Counter will be loaded with the new count on the next CLK pulse and counting will continue from the new count. Otherwise, the new count will be loaded at the end of the current counting cycle. In mode2, a COUNT of 1 I illegal.

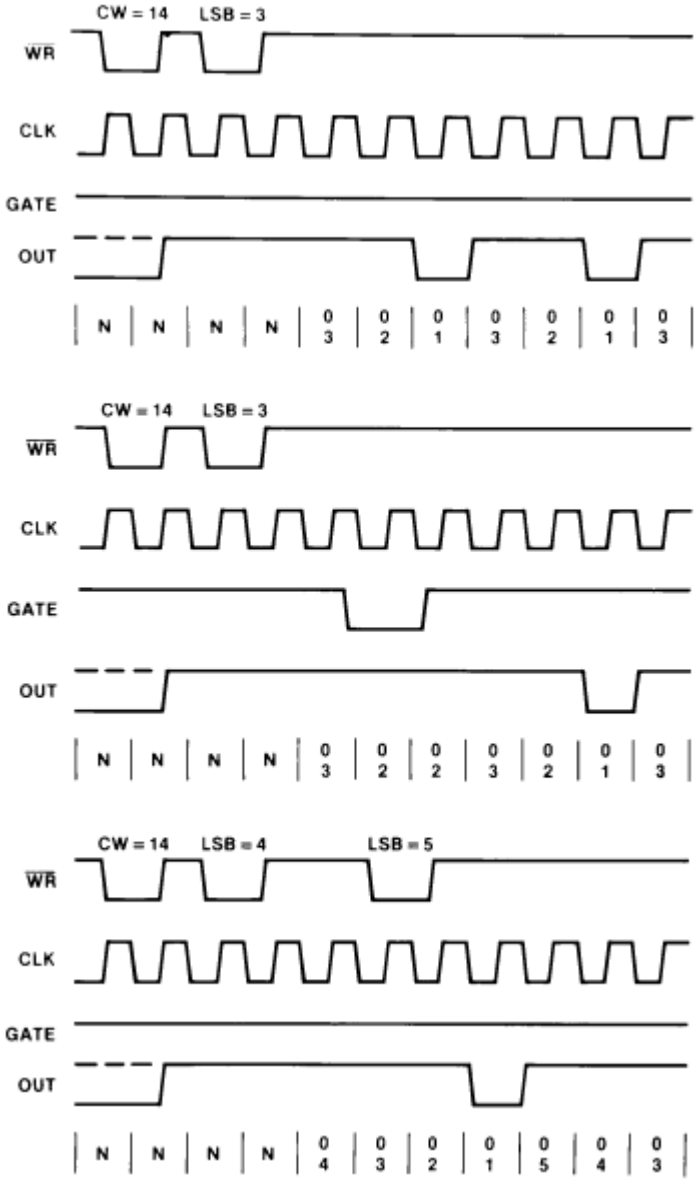


Figure 7.3 Mode 2

Note: A GATE transition should not occur one clock prior to terminal count.

MODE 3 Square wave mode

Mode 3 is typically used for Baud rate generation. Mode 3 is similar to Mode 2 except for the duty cycle of OUT. OUT will initially be high. When half the initial count has expired, OUT goes low for mainder of the count. Mode 3 is periodic; the sequence above is repeated indefinitely. An initial count of N results in a square wave with a period of N CLK cycles.

GATE=1 enables counting; GATE=0 disables counting. If GATE goes low while OUT is low, OUT is set high

immediately; no CLK pulse is required. A trigger reloads the Counter with the initial count on the next CLK pulse. Thus the GATE input can be used to synchronize the Counter

After writing a Control Word and initial count, the Counter will be loaded on the next CLK pulse. This allows the Counter to be synchronized by software also.

Writing a new count while counting does not affect the current counting sequence. If a trigger is received after writing a new count but before the end of the current half-cycle of the square wave, the Counter will be loaded with the new count on the next CLK pulse and counting will continue from the new count. Otherwise, the new counter will be loaded at the end of the current half-cycle.

Mode 3 is implemented as follows:

Even counts: OUT is initially high. The initial count is loaded on one CLK pulse and then is decremented by two on succeeding CLK pulses. When the count expires OUT changes value and the Counter is reloaded with the initial count. The above process is repeated indefinitely.
Odd counts: OUT is initially high. The initial count minus one (an even number) is loaded on one CLK pulse and then is decremented by two on succeeding CLK pulses. One CLK pulse after the count expires. OUT goes low and the Counter is reloaded with the initial count minus one. Succeeding CLK pulses decrement the count by two. When the count expires, OUT goes high again and the Counter is reloaded with the initial count minus one. The above process is repeated indefinitely. So for odd counts, OUT will be high for (N+1)/2 counts and low for (N-1)/2 counts.

MODE 4 Software triggered strobe

OUT will be initially high. When the initial count expires, OUT will go low for one CLK pulse and then go high again. The counting sequence is “triggered” by writing the initial count.

GATE=1 enables counting; GATE=0 disables counting. GATE has no effect on OUT.

After writing a Control Word and initial count, the Counter will be loaded on the next CLK pulse. This CLK pulse does not decrement the count, so for an initial count of N, OUT does not strobe low until N+1 CLK pulses after the initial count is written.

If a new count is written during counting, if will be loaded on the next CLK pulse and counting will continue from the new count. If a two-byte count is written, the following happens:
1) Writing the first byte has no effect on counting.
2) Writing the second byte allows the new count to be loaded on the next CLK pulse.
This allows the sequence to be ‘‘retriggered’ by software. OUT strobe low N+1 CLK pulses after
the new count of N is written.

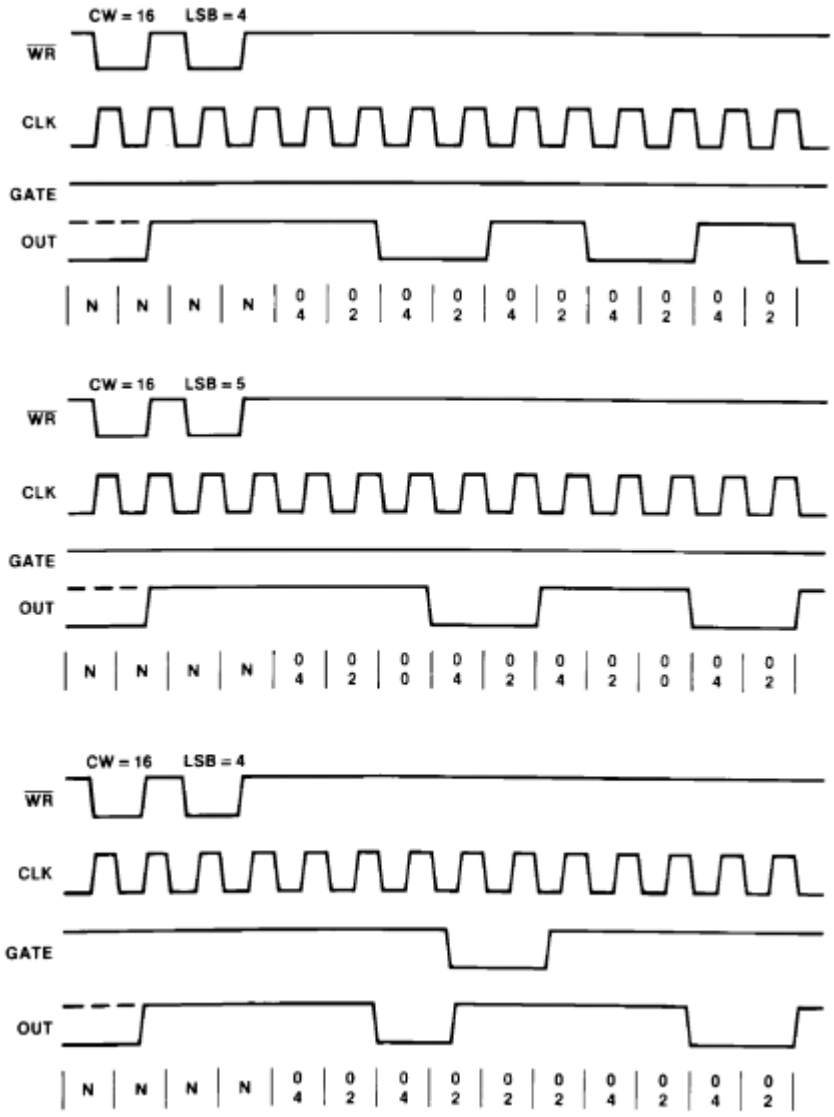


Figure 7.4 Mode 3

Note: A GATE transition should not occur one clock prior to terminal count.

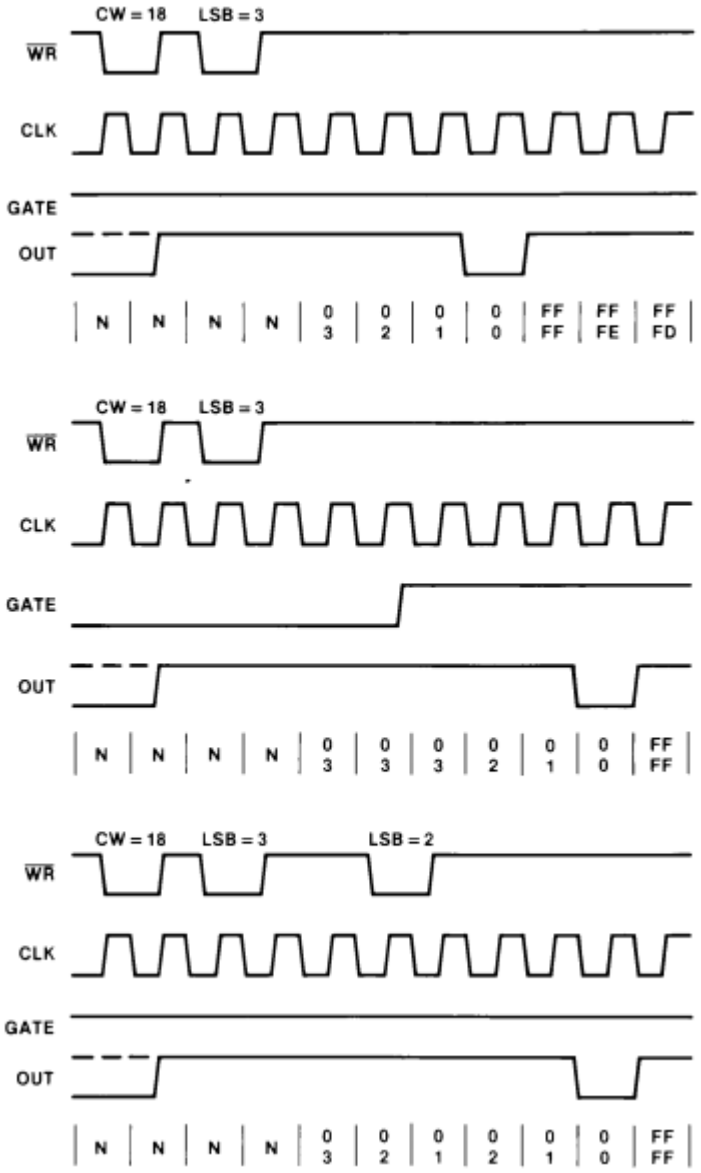


Figure 7.5 Mode 4

MODE 5 Hardware triggered strobe

OUT will initially be high. Counting is triggered by a rising edge of GATE. When the initial count has expired, OUT will go low for one CLK pulse and then go high again.

After writing the Control Word and initial count, the counter will not be loaded until the CLK pulse after a trigger. This CLK pulse does not decrement the count, so for an initial count of N, OUT does not strobe low until N+ 1 pulse after a trigger.

A trigger results in the Counter being loaded with the initial count on the next CLK pulse. The counting sequence is retriggerable. OUT will not strobe low for N+1 CLK pulses after any trigger. GATE has no effect on OUT.
If a new count is written during counting, the current counting sequence will not be affected. If a trigger occurs after the new count is written but before the current count expires, the Counter will be loaded with the new count on the next CLK pulse and counting will continue from there.

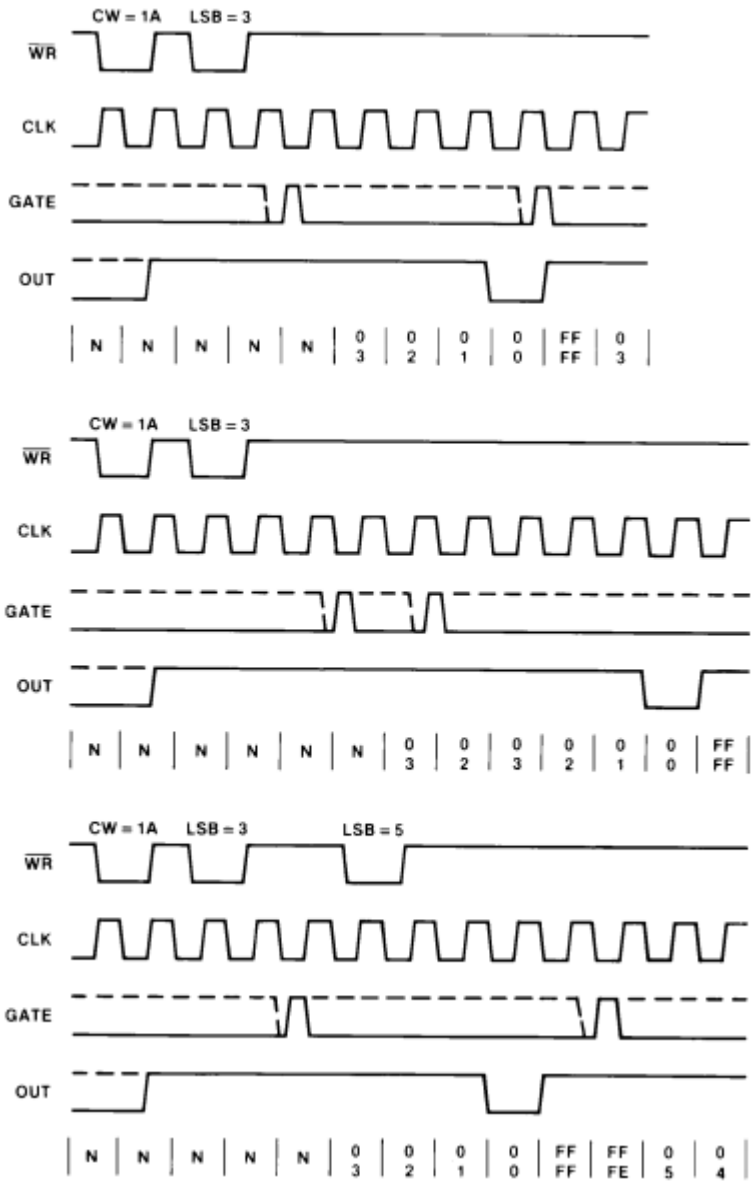


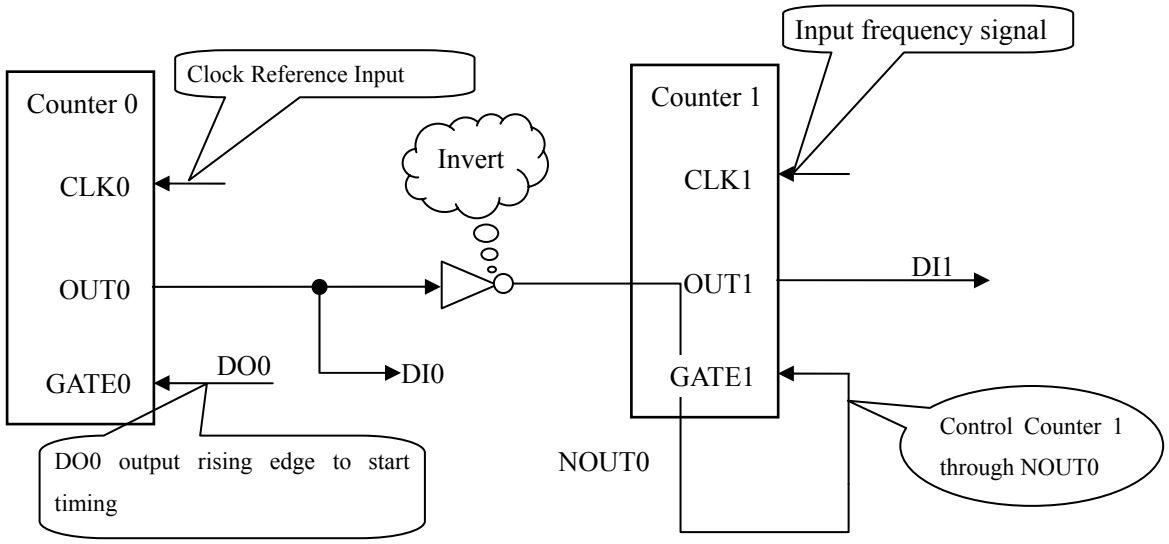
Figure 7.6 Mode 5

The function of the “GATE” signal.

GATE	Low level or Falling edge	Rising edge	High level
Mode 0	Counting is forbidden	No effect	Allowed to count
Mode 1	No effect	1. Start counting after the initial value is given. 2. Re-start to counting from the initial value during one counting period.	No effect
Mode 2	Counting is forbidden and output high level	Start counting	Allowed to count
Mode 3	Counting is forbidden and output high level	Start counting	Allowed to count
Mode 4	Counting is forbidden	No effect	Allowed to count
Mode 5	No effect	1. Start counting after the initial value is given. 2. Re-start to counting from the initial value during one counting period.	No effect

Note: each timer/counter of 8254 can not set the initial value to “1” in all operating modes, for the timer/counter will stop counting and output.

7.2 Measure the frequency of an unknown frequency signal source.



Note: Counter 0 is timing channel (Mode 1), counter 1 is counting channel (Mode 0, record the number of measured signal pulse). GATE0 is controlled by DO0. Counter 0 is given an initial value which is corresponding to the time in advance. Counter is given the maximum count initial value (FFFFH). When DO0 has a rising edge, counter 0 start to timing count, its “OUT0” becomes low level; “NOUT0” becomes high level. So “GATE1” is high level, counter 1 start

to count to record the number of measured signal pulse. If counter1 counting to zero within counter 1' time, "OUT1" turns to high level. Users can read the state of DI1 to judge whether counter 1 is overflow or not. In addition, the user can read DI0 in order to judge whether the frequency measurement has completed. If DIO is high level, the frequency measurement has completed, read the value of counter 1.

At the same time it is necessary to check the state of DI1. If the state of DI1 is low level, the measured frequency is valid. If the state of DI1 is high level, the measured frequency is invalid, and re-measurement is needed. If DO0 has another rising edge, new measure can be re-started.

Chapter 8 Notes, Calibration and Warranty Policy

8.1 Notes

In our products' packing, user can find a user manual, a USB2815 module and a quality guarantee card. Users must keep quality guarantee card carefully, if the products have some problems and need repairing, please send products together with quality guarantee card to ART, we will provide good after-sale service and solve the problem as quickly as we can.

When using USB2815, in order to prevent the IC (chip) from electrostatic harm, please do not touch IC (chip) in the front panel of USB2815 module.

8.2 Analog Signal Input Calibration

Every device has to be calibrated before sending from the factory. It is necessary to calibrate the module again if users want to after using for a period of time or changing the input range. USB2815 default input range: ±10V, in the manual, we introduce how to calibrate USB2815 in ±10V, calibrations of other input ranges are similar.

Prepare a digital voltage instrument which the resolution is more than 5.5 bit, install the USB2815 module, and then power on, warm-up for fifteen minutes.

1) Zero adjustment: select one channel of analog inputs, take the channel AI0for example, connect 0V to AI0, and then run ART Data Acquisition Measurement Suite in the WINDOWS. Choose channel 0, ±10V input range and start sampling, adjust potentiometer RP1 in order to make voltage value is 0.000V or about 0.000V. Zero adjustment of other channels is alike.
2) Full-scale adjustment: select one channel of analog inputs, take the channel AI0 for example, connect 9999.69mV to AI0, and then run ART Data Acquisition Measurement Suite in the WINDOWS. Choose channel 0, ±10V input range and start sampling, adjust potentiometer RP2 in order to make voltage value is 9999.69mV or about 9999.69mV. Full-scale adjustment of other channels is alike.
3) Repeat steps above until meet the requirement.

8.3 Analog Signal Output Calibration

In the manual, we introduce how to calibrate USB2815 in ±5V output range; calibrations of other input ranges are similar.

1) Connect the ground of the digital voltage meter to any analog AGND. Connect the input side of the voltage meter to the DA which needs calibration. Run USB2815 test procedure under Windows, select the analog output detection.
2) Set the analog output value to 2048, adjust potentiometer RP7 in order to make output to 0.000V.
3) Set the analog output value to 4095, adjust potentiometer RP3 in order to make AO0 output value to 4997.55mV.
4) Repeat steps above until meet the requirement.

8.4 Analog output use

In demonstration program, the continuous output interval of waveform output can not be carried out; the main objective is to test the strength of analog output.

8.5 Warranty Policy

Thank you for choosing ART. To understand your rights and enjoy all the after-sales services we offer, please read the following carefully.

1. Before using ART's products please read the user manual and follow the instructions exactly. When sending in damaged products for repair, please attach an RMA application form which can be downloaded from: www.art-control.com.
2. All ART products come with a limited two-year warranty:
   - The warranty period starts on the day the product is shipped from ART's factory
   - For products containing storage devices (hard drives, flash cards, etc.), please back up your data before sending them for repair. ART is not responsible for any loss of data.
   - Please ensure the use of properly licensed software with our systems. ART does not condone the use of pirated software and will not service systems using such software. ART will not be held legally responsible for products shipped with unlicensed software installed by the user.
3. Our repair service is not covered by ART's guarantee in the following situations:
   - Damage caused by not following instructions in the User's Manual.
   - Damage caused by carelessness on the user's part during product transportation.
   - Damage caused by unsuitable storage environments (i.e. high temperatures, high humidity, or volatile chemicals).
   - Damage from improper repair by unauthorized ART technicians.
   - Products with altered and/or damaged serial numbers are not entitled to our service.
4. Customers are responsible for shipping costs to transport damaged products to our company or sales office.
5. To ensure the speed and quality of product repair, please download an RMA application form from our company website.

Products Rapid Installation and Self-check

Rapid Installation

Product-driven procedure is the operating system adaptive installation mode. After inserting the disc, you can select the appropriate board type on the pop-up interface, click the button【driver installation】; or select CD-ROM drive in Resource Explorer, locate the product catalog and enter into the APP folder, and implement Setup.exe file. After the installation, pop-up CD-ROM, shut off your computer, insert the USB card. If it is a USB product, it can be directly inserted into the device. When the system prompts that it finds a new hardware, you do not specify a drive path, the operating system can automatically look up it from the system directory, and then you can complete the installation.

Self-check

At this moment, there should be installation information of the installed device in the Device Manager (when the device does not work, you can check this item.). Open "Start -> Programs -> ART Demonstration Monitoring and Control System -> Corresponding Board -> Advanced Testing Presentation System", the program is a standard testing procedure. Based on the specification of Pin definition, connect the signal acquisition data and test whether AD is normal or not. Connect the input pins to the corresponding output pins and use the testing procedure to test whether the switch is normal or not.

Delete Wrong Installation

When you select the wrong drive, or viruses lead to driver error, you can carry out the following operations: In Resource Explorer, open CD-ROM drive, run Others-> SUPPORT-> USB.bat procedures, and delete the hardware information that relevant to our boards, and then carry out the process of section I all over again, we can complete the new installation.